WHAT IS CLAIMED IS:

[c01] 1. A method of monitoring machining in an electrochemical machining tool assembly having at least one electrode arranged across a gap from a workpiece, the electrode being energized by application of a potential difference ΔV between the electrode and the workpiece, said method comprising:

exciting at least one ultrasonic sensor to direct an ultrasonic wave toward a surface of the electrode;

receiving a reflected ultrasonic wave from the surface of the electrode using the ultrasonic sensor, the reflected ultrasonic wave comprising a plurality of reflected waves from the surface of the electrode and from a surface of the workpiece; and

delaying the excitation of the ultrasonic sensor a dwell time T_d after a reduction of the potential difference ΔV across the electrode and the workpiece occurs.

[c02] 2. The method of Claim 1, wherein the electrochemical machining tool assembly is a pulsed electrochemical machining tool assembly, and wherein the electrode is energized by a periodic application of the potential difference ΔV between the electrode and the workpiece during a plurality of pulse-on periods, and wherein the delaying comprises delaying the excitation of the ultrasonic sensor the dwell time T_d after a transition from the pulse-on state to a pulse-off state.

[c03] 3. The method of Claim 1, wherein the electrochemical machining tool assembly is a continuous electrochemical machining tool assembly, said method further comprising:

repeatedly reducing the potential difference ΔV across the electrode and the workpiece to generate a series of measurement periods Δt_M,

wherein the delaying comprises delaying the excitation of the ultrasonic sensor a dwell time T_d after a start of one of the measurement periods Δt_M.

[c04] 4. The method of Claim 1, wherein the dwell time T_d is in a range of about seven milliseconds (7 ms) to about 15 milliseconds (15 ms).

[c05] 5. The method of Claim 1, further comprising adjusting the dwell time T_d.

[c06] 6. The method of Claim 5, wherein the adjusting comprises decreasing the dwell time T_d.

[c07] 7. The method of Claim 5, wherein the adjusting comprises increasing the dwell time T_d.

[c08] 8. The method of Claim 1, wherein the electrochemical machining tool assembly has at least two electrodes, each of the electrodes being arranged across a respective gap from the workpiece.

[c09] 9. The method of Claim 8, wherein the exciting comprises exciting a first ultrasonic sensor to direct an ultrasonic wave toward a surface of one of the electrodes and exciting a second ultrasonic sensor to direct an ultrasonic wave toward a surface of another of the electrodes,

wherein the receiving comprises receiving respective reflected ultrasonic waves from the surface of each of the respective electrodes using the respective ultrasonic sensors, and

wherein the delaying comprises delaying the excitation of a first one of the ultrasonic sensors the dwell time T_d after a reduction of the potential difference ΔV across the electrodes and the workpiece occurs and delaying the excitation of the other of the

ultrasonic sensors the dwell time T_d plus an offset δ after a reduction of the potential difference ΔV across the electrodes and the workpiece occurs, where the offset δ is at least the time required to attenuate the ultrasonic wave from the first one of the ultrasonic sensors.

[c10] 10. The method of Claim 1, further comprising analyzing the reflected ultrasonic wave to determine at least one of (a) a size of the gap between the electrode and the workpiece and (b) a thickness of the workpiece.

[c11] 11. The method of Claim 1, wherein the ultrasonic sensor comprises an ultrasonic transducer.

[c12] 12. A method of monitoring machining in a pulsed electrochemical machining tool assembly having at least one electrode arranged across a gap from a workpiece, the electrode being periodically energized by application of a plurality of pulses, said method comprising:

exciting at least one ultrasonic sensor to direct an ultrasonic wave toward a surface of the electrode;

receiving a reflected ultrasonic wave from the surface of the electrode using the ultrasonic sensor, the reflected ultrasonic wave comprising a plurality of reflected waves from the surface of the electrode and from the surface of the workpiece; and

delaying the excitation of the ultrasonic sensor a dwell time T_d after a transition from a pulse-on state to a pulse-off state.

[c13] 13. The method of Claim 12, further comprising adjusting the dwell time T_d.

[c14] 14. The method of Claim 12, wherein the dwell time T_d is in a range of about seven milliseconds (7 ms) to about 15 milliseconds (15 ms).

[c15] 15. An electrochemical machining method for machining a workpiece comprising:

energizing at least one electrode positioned in proximity to the workpiece, the electrode and the workpiece being separated by a gap;

flowing an electrolyte through the gap;

flushing the electrolyte from the gap;

feeding the at least one electrode toward the workpiece; and

monitoring at least one of the gap and the workpiece using at least one ultrasonic sensor, the monitoring comprising:

exciting the ultrasonic sensor to direct an ultrasonic wave toward a surface of the electrode,

receiving a reflected ultrasonic wave from the surface of the electrode using the ultrasonic sensor, the reflected ultrasonic wave comprising a plurality of reflected waves from the surface of the electrode and from the surface of the workpiece, and

delaying the excitation of the ultrasonic sensor a dwell time T_d after a reduction of the potential difference ΔV across the electrode and the workpiece occurs.

[c16] 16. The method of Claim 15, wherein the monitoring further comprises adjusting the dwell time T_d.

[c17] 17. The method of Claim 15, wherein the dwell time T_d is in a range of about seven milliseconds (7 ms) to about 15 milliseconds (15 ms).

[c18] 18. The method of Claim 15, wherein the electrochemical machining tool assembly is a pulsed electrochemical machining tool assembly, and

wherein the energizing comprises a periodic application of the potential difference ΔV between the electrode and the workpiece during a plurality of pulse-on periods, and wherein the delaying comprises delaying the excitation of the ultrasonic sensor the dwell time T_d after a transition from the pulse-on state to a pulse-off state.

[c19] 19. The method of Claim 15, wherein the electrochemical machining tool assembly is a continuous electrochemical machining tool assembly, said method further comprising:

repeatedly reducing the potential difference ΔV across the electrode and the workpiece to generate a series of measurement periods Δt_M,

wherein the delaying comprises delaying the excitation of the ultrasonic sensor the dwell time T_d after a start of one of the measurement periods Δt_M.

[c20] 20. The method of Claim 15, wherein the monitoring further comprises generating monitoring data by analyzing the reflected ultrasonic wave to determine at least one of (a) a size of the gap between the electrode and the workpiece and (b) a thickness of the workpiece.

[c21] 21. The method of Claim 20, further comprising controlling at least one of the energizing and the feeding in response to the monitoring data.

[c22] 22. An electrochemical machining tool assembly comprising:

at least one electrode adapted to machine a workpiece across a gap upon application of a potential difference ΔV across said electrode and the workpiece;

means for flowing an electrolyte through the gap and for flushing the electrolyte from the gap;

means for feeding said at least one electrode toward the workpiece;

at least one ultrasonic sensor adapted to direct an ultrasonic wave toward a surface of said electrode and to receive a reflected ultrasonic wave from the surface of said electrode, the reflected ultrasonic wave comprising a plurality of reflected waves from the surface of said electrode and from a surface of the workpiece; and

a delay generator adapted to delay the excitation of said ultrasonic sensor a dwell time T_d after a reduction of the potential difference ΔV across said electrode and the workpiece occurs.

[c23] 23. The electrochemical machining tool assembly of Claim 22, further comprising:

a power supply adapted to energize said at least one electrode for machining by applying the potential difference ΔV across said at least one electrode and the workpiece; and

at least one pulser-receiver connected to a respective one of said at least one ultrasonic sensors, each of said at least one pulser-receivers being adapted to excite the respective ultrasonic sensor and to receive the respective reflected ultrasonic wave, each of said at least one pulser-receivers being further adapted to be triggered by said delay generator to excite the respective ultrasonic sensor after the dwell time T_d after a reduction of the potential difference ΔV across said electrode and the workpiece occurs.

[c24] 24. The electrochemical machining tool assembly of Claim 23, wherein said delay generator is adapted to monitor the output from said power supply.

[c25] 25. The electrochemical machining tool assembly of Claim 23, wherein said power supply is adapted to supply a plurality of pulses to generate the potential difference ΔV between said at least one electrode and the workpiece during a plurality of pulse-on periods, and wherein said delay generator is adapted to delay the excitation of said at least one ultrasonic sensor the dwell time T_d after a transition from the pulse-on state to a pulse-off state.

[c26] 26. The electrochemical machining tool assembly of Claim 23, wherein said power supply is a DC power supply adapted to apply the potential difference ΔV across said at least one electrode and the workpiece, said electrochemical machining tool assembly further comprising a controller adapted to repeatedly reduce the potential difference ΔV applied across said at least one electrode and the workpiece to generate a series of measurement periods Δt_M,

wherein said delay generator is adapted to delay the excitation of said ultrasonic sensor the dwell time T_d after a start of one of the measurement periods Δt_M.

[c27] 27. The electrochemical machining tool assembly of Claim 23, wherein the dwell time T_d is in a range of about seven milliseconds (7 ms) to about 15 milliseconds (15 ms).

[c28] 28. The electrochemical machining tool assembly of Claim 23, wherein said delay generator is adapted to adjust the dwell time T_d.

[c29] 29. The electrochemical machining tool assembly of Claim 23, further comprising a controller, said controller being adapted to generate a plurality of monitoring data by analyzing the reflected ultrasonic wave to determine at least one of (a) a size of the gap between said electrode and the workpiece and (b) a thickness of the workpiece.

[c30] 30. The electrochemical machining tool assembly of Claim 29, wherein said controller is further adapted to control at least one of (a) said means for

feeding said at least one electrode toward the workpiece and (b) said power supply, in response to the monitoring data.

[c31] 31. The electrochemical machining tool assembly of Claim 23, wherein each of said at least one ultrasonic sensors comprises an ultrasonic transducer.